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US 3894718

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(54) Rotary valves

(57) In a valve which includes a member (C) rotatable in a valve chamber (12) and co-operating with at least one seal assembly (B) which comprises a disc spring (114) and a preferably resilient seat ring (100), a normally occurring void (120) in the valve chamber (12) is filled through use of a dead space ring (122) preferably formed of a rigid, low friction material which does not substantially increase the torque required to rotate the ball member and prevents cold flow of the material into the fluid passageway. As shown two such seal assemblies (B) are provided, and a support ring (86) may be interposed between the rings (100) and (122).

FIG.1

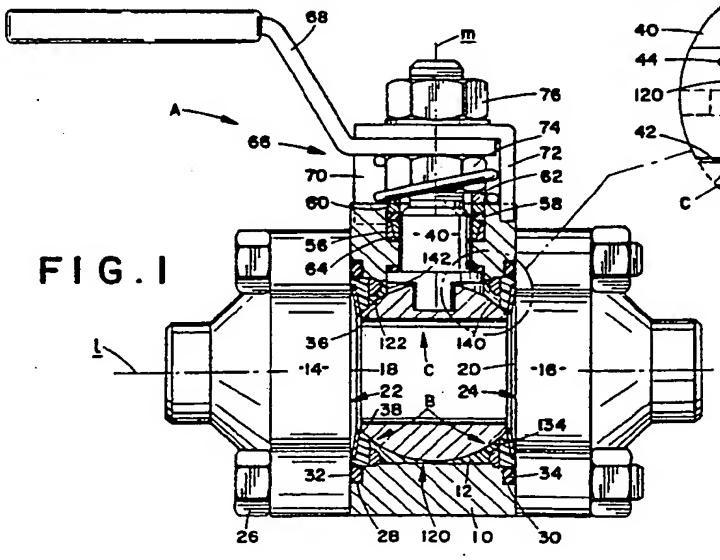
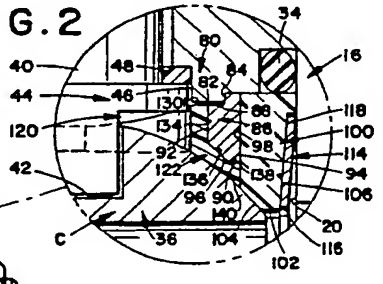


FIG.2



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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

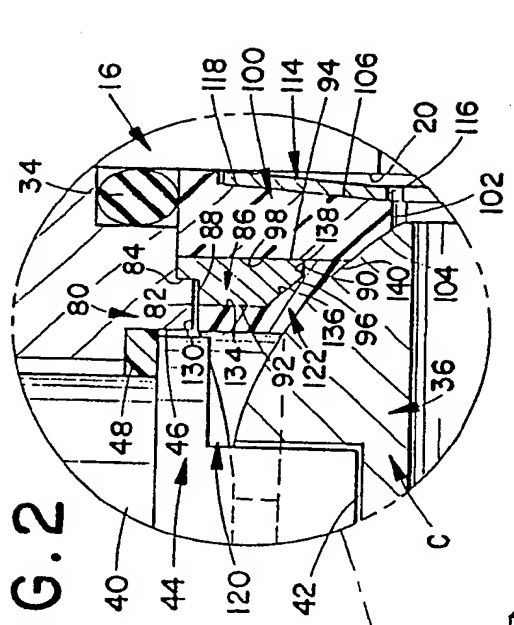


FIG. 2

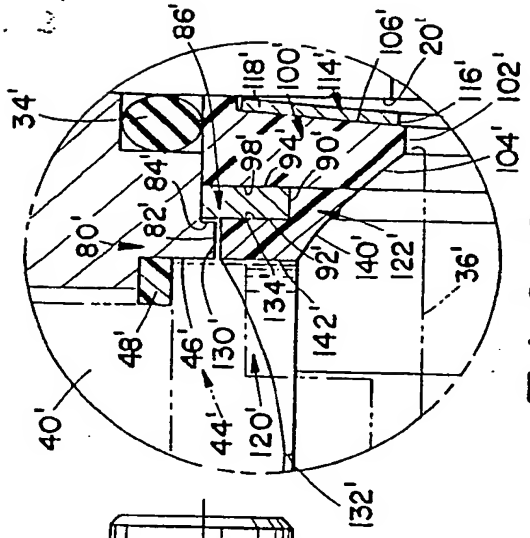


FIG. 2A

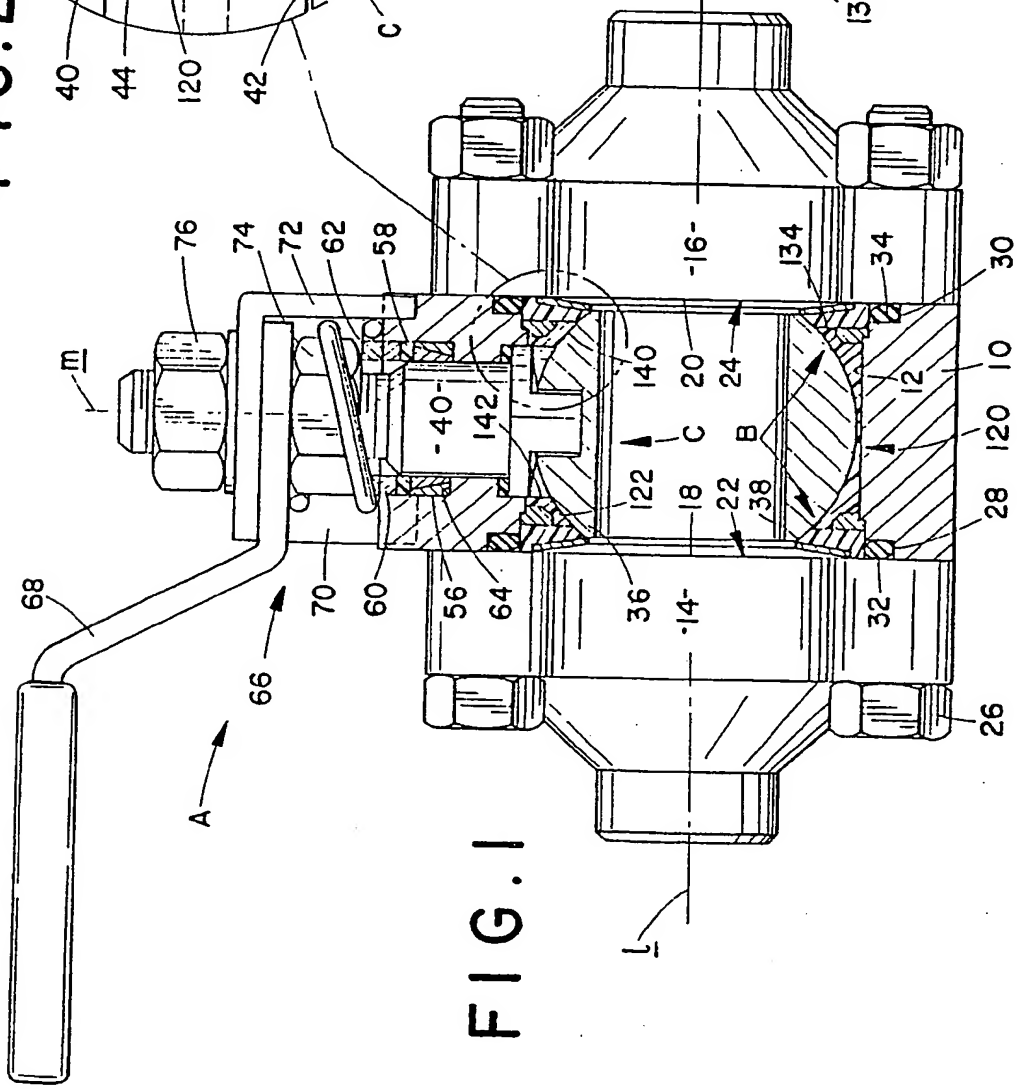
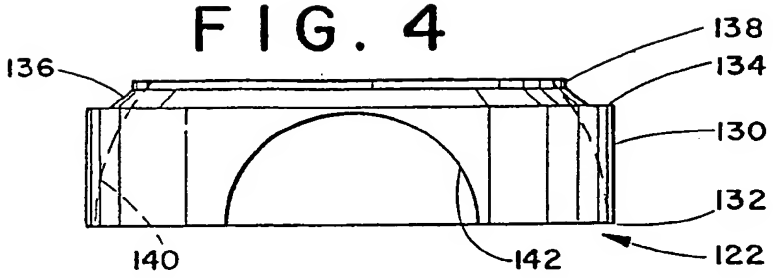


FIG. 1

FIG. 4



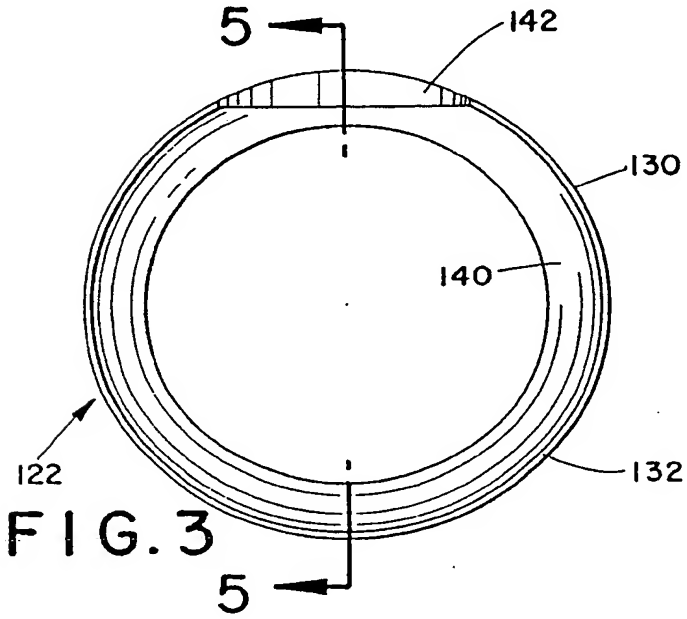


FIG. 3

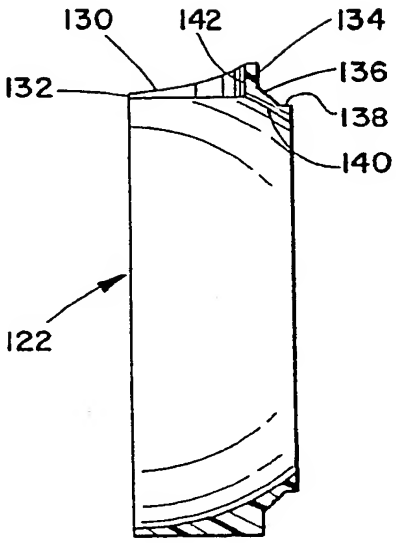


FIG. 5

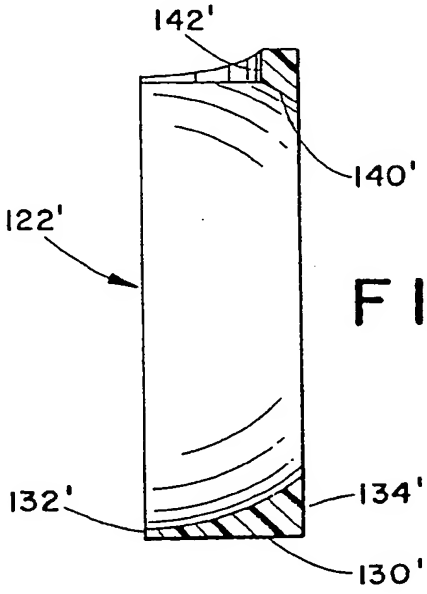


FIG. 5A

SPECIFICATION

Rotary valves

This invention pertains to rotary valves, such as ball valves. The invention is particularly applicable to a ball valve incorporating a low dead space ring and will be described with particular reference thereto. However, the invention has broader applications and can be adapted to use in other types and styles of valves.

U.S.A. Patents Nos. 3,894,718 and 4,410,165 detail the evolution and development of seal assemblies utilized in ball valves. Generally, early developments of valve seat assemblies for ball valves employed an elementary seat design which included a pair of annular plastic seats which were compacted between the ball member and the wall portions of end fittings. Such seat designs suffered from a number of problems including low sealing forces at low pressure or vacuum conditions, and valve leakage due to wear and tolerance errors.

These early seat designs gave way to a contoured seat design in which the ball member was engaged along its outer periphery by a narrow band or line contact. Wear problems also developed with contoured seat designs and they gave way to the development of the flexible seat. The flexible seat, though, only provided improved operation for short periods of time. A seat ring with a disc spring, as well as an upstream seat bypass arrangement, were other improvements developed by the industry which progressively overcame various problems associated with ball valve seating arrangements. U.S.A. Patent No. 4,410,165 describes a seal assembly which includes a support ring, a disc spring, and a set ring. This assembly provides additional seat ring support in a floating ball type of valve which is applicable to use in high fluid pressure environments. A longer life span was, in turn, realized at a cost saving with respect to other known seating arrangements.

More specifically, the seat assembly structure of U.S.A. Patent No. 4,410,165 utilizes a pair of resilient seat rings disposed on opposite sides of the ball member. A disc spring is interposed between the end fittings and the seat rings to urge the seat rings continuously into sealing engagement with the ball member. A reinforcing or support ring is disposed at a forward surface of each seat ring for positive locating engagement with a shoulder extending into the valve chamber.

U.S.A. Patent No. 4,602,762 describes a similar seat ring assembly. It recognizes that a reinforcing or support ring need not necessarily be incorporated into the valve seal structure. Instead, any bearing surface disposed in the valve passageway for abutting engagement with the seat ring may be used with equal success.

These latter two arrangements have proved to be quite satisfactory but, after continued use in environments filled with contaminants, the open spaces or voids defined between the ball member, the seal assemblies, and the valve chamber walls are subject to eventual contaminant deposit. This contaminant deposit has an adverse effect on the sealing integrity of the ball valve. It has, therefore, been deemed desirable to fill these open spaces or voids in ball valves to further limit the area available in the interior of the valve which could otherwise accommodate fluid flow around the ball. Any such arrangement should not interfere with or reduce the effectiveness of the seal assemblies themselves.

An object of the present invention is to meet these and other needs in providing a new low dead space ring construction.

In accordance with the present invention, a valve is provided having a valve member disposed for selective movement between open and closed positions within a valve chamber. Seal assemblies are disposed on opposite sides of the valve member, and each seal assembly is comprised of at least a seal ring and a disc spring. The disc spring functions to continuously urge the seat ring into sealing engagement with the valve member. At least one dead space ring is adapted for receipt in the area of the valve chamber between the valve member, seal assemblies, and the valve chamber walls for reducing the volume of the void or open space therein.

In accordance with another aspect of the invention, the dead space ring has a first rounded or curvilinear surface adapted for generally mating engagement with the valve member.

In accordance with a further aspect of the invention, the dead space ring is constructed of a low friction material, such as polytetrafluoroethylene or the like.

In accordance with a still further aspect of the invention, the dead space ring is constructed of a rigid plastic-like material to limit cold flow thereof.

An advantage of the invention is the filling of dead space within a valve to effectively limit or reduce the open area otherwise available in the valve chamber which would enable fluid flow around the valve member.

Another feature of the invention resides in a structure for a dead space ring which does not cause a substantial increase in the torque required to open and close the valve.

The invention is further described, by way of example, with reference to the accompanying drawings, in which:—

Figure 1 is a side elevational view, in partial section, of a ball valve in accordance with the invention;

Figure 2 is an enlarged detail view of the ball valve shown in Fig. 1 at an area thereof

adjacent a seat assembly;

Figure 2A is a view similar to Fig. 2 showing an alternative construction in accordance with the invention;

Figure 3 is an end view of a preferred dead space ring used in accordance with the invention;

Figure 4 is a plan view of the dead space ring of Fig. 3;

Figure 5 is a cross-sectional view taken along lines 5–5 of Fig. 3; and

Figure 5 is a cross-sectional view similar to Fig. 5 showing an alternative dead space ring used in the embodiment of Fig. 2A.

Referring now to the drawings, Fig. 1 shows a ball valve A having a pair of seal assemblies B disposed on opposite sides of a floating-type spherical ball or valve member C. The ball member is adapted for selective rotation between valve-closed and open positions as is well known in the art.

In Fig. 1, the ball valve A includes a body or housing 10 having a central opening extending therethrough and defining a valve chamber 12. A pair of end fittings 14, 16 are situated at opposed ends of the body 10 and include a pair of shoulders 18,20 defined by end faces 22,24 of the end fittings. The end fittings are secured to the body by conventional means, such as elongated tie bolts 26 and are adapted for retaining the seal assemblies B in generally mating engagement with the ball valve A. Through openings (not shown) are provided in the respective end fittings generally along longitudinal axis 1 of the valve body to enable fluid communication between the valve chamber 12 and an external fluid system or associated piping in a known manner. A pair of grooves 28,30 at opposite ends of the body are open axially towards the end fittings and radially towards the seal assemblies and receive seal members 32,34 such as O-rings or the like. In this manner, the end fittings and seal assemblies may be placed in sealed relationship with the valve body 10.

A ball member 36 is dimensioned for close receipt within the valve chamber 12, occupying a major portion of the chamber, and has an axial passage 38 therethrough. The ball member is adapted for selective rotation about a stem axis m to align the passage 38 with the respective through openings formed in the end fittings. As is known, a spade portion of a stem 40 is operatively received in a slot or groove 42 in the ball member. The stem penetrates through the side wall of the body and includes a radially extending flange 44 (Fig. 2) co-operable with a recessed or counterbalanced area 46 formed in the body to prevent removal of the stem outwardly from the body along stem axis m. In addition, flange 44 provides a lower support for a thrust washer 48.

With reference again to Fig. 1, stem packing members 56, 58, 60, 62 are disposed at axially-spaced intervals about the stem. The lowermost packing member 56 may be comprised of a pair of chevron packings which cooperate along facing angularly oriented faces. Application of axial pressure to the chevron packings thus exerts a tight, radially directed sealing force against the stem and body. Packings 56, 58, 60 are supported by a shoulder 64 formed in the body. Cylindrical metal gland 62 transfers compressive forces to the remaining stem packing members supported in the body. An analogous stem packing structure and function is detailed in U.S.A. Patent No. 4,558,874.

An actuating mechanism 66 comprises a handle member 68 and includes a pair of downwardly depending stop surfaces 70,72 for predetermined engagement with the exterior of the body 10 at valve open and closed conditions. Two nuts 74,76 are threadedly received on the stem at lower and upper surfaces of the handle, respectively, for placing the stem packing in a proper sealing condition and for clamping retaining the handle member on the stem. However, other types of actuating means may be satisfactorily employed without departing from the scope of the invention.

With primary reference to Fig. 2, as well as continued reference to Fig. 1, description will be made of the specific details of the seal assemblies B. Fig. 2 particularly illustrates a portion of one seal assembly in the assembled condition. The following description is equally applicable to the other seal assembly unless otherwise specifically noted. First, a circumferentially continuous shoulder 80 extends inwardly into valve chamber 12 from the body 10, and is defined by a first axially extending surface 82 and a second radially extending bearing or support surface 84. Seal assembly B includes a reinforcing or support ring 86 having a notch-like first surface 88 abuttingly engaging radial surface 84 of the shoulder. The support ring 86 has a through opening 90 radially spaced from the outer circumference of the ball member, and radially oriented end surfaces 92,94 which are substantially parallel to one another. The support ring also has a conical second surface 96 interconnecting the opening 90 and the end surface 92. This conical surface is in generally parallel spaced relation with the circumference of the ball member 36. Moreover, support ring end surface 94 is adapted for abutting engagement with a first surface 98 of a seat ring 100.

Alternatively, and as described above with respect to U.S.A. Patent No. 4,602,762, a reinforcing or support ring 86 need not be incorporated into selected valve structures. If the support ring is eliminated, bearing surface 84 will necessarily support the first surface 98 of the seat ring without any adverse effect. The remaining description will refer to a valve structure utilizing a separate support ring inter-

posed between circumferential shoulder 80 and seat ring 100, although the support ring could be eliminated in certain, selected valve arrangements and the remaining structure function in substantially the same manner.

The seat ring 100 is formed of a resilient material such as a plastic or plastic-like material. Such material may, however, vary depend upon the specific operating conditions to which the valve will be subjected. The seat ring has a through opening 102 disposed radially inwardly with respect to the opening 90 of the support ring 86. A second, generally curvilinear or part spherical surface 104 has a radius of curvature in an unstressed, unassembled condition which is greater than the radius of curvature on the outer surface of the ball member C. A third surface 106 faces the adjacent end fitting 16, and is frustoconical and generally parallel to the first surface 98 of the seat ring. The third surface is adapted for engagement by a disc spring 114.

In an uncompressed state, the disc spring 114 has a generally frustoconical shape. When assembled in the ball valve, the disc spring is moved towards a substantially flattened condition so that a first radially inner portion 116 engages the seat ring at third surface 106 while a radially outer portion 118 abuts the shoulder 20 of end fitting 16. The flattened condition of the disc spring causes the seat ring 100 to be continuously biased into a sealing relationship with the ball member 36 substantially along the curvilinear surface 104 in the manner illustrated.

Repeated opening and closing of the valve, especially in a harsh fluid system environment, result in the passage of contaminants into the cavity 120 (Figs. 1 and 2) formed between the ball member, valve chamber, and seal assemblies. Entry of contaminants into this cavity can restrict or reduce proper functioning of the valve. The invention provides a precise path for the flow of fluid through the valve and prohibts entry of fluid into the cavity 120 whereby the effective valve life is extended and the valve functions smoothly.

As illustrated in Figs. 1 and 2, the cavity 120 is substantially filled through use of a pair of identical dead space rings 122. One of the dead space rings 122 is shown in detail in Figs. 3 to 5 and the other dead space ring is identical thereto. The dead space rings are comprised of a low friction material to limit any increase in torque required for operating the valve in view of the presence of such dead space rings. For example, the preferred and alternative embodiments of the dead space rings which are described herein utilize polytetrafluoroethylene impregnated with reinforcing glass or carbon fibre. However, other materials could also be used to satisfy different operating conditions and/or parameters.

More specifically, the outer surface or circumference 130 of ring 122 is designed for close mating receipt by the side wall of the valve chamber 12. In the preferred embodiment shown, the outer surface of the dead space ring 122 has a generally smooth contour and extends from an inner edge 132 to a rear shoulder 134. The ring further includes an outer, tapered surface 136 interposed between shoulder 134 and an outer edge portion 138. As particularly shown in Fig. 2, the shoulder 134, tapered surface 136, and outer edge portion 138 conform to the end face 92, curvilinear surface 96, and opening 90, respectively, of the support ring 86. A central, through opening in the ring is defined by a generally curvilinear or part spherical surface 140 and is concentrically spaced from the outer circumference 130 for establishing a close mating relationship with the outer surface of the ball member. The central opening gradually decreases in size from its largest diameter at inner edge 132 to its smallest diameter at outer edge portion 138 (Fig. 4). The inner edge 132 of the dead space ring shown in Figs. 3 to 5 abuts or nearly abuts the corresponding edge on the other dead space ring. Also, outer edge portion 138 of each dead space ring engages first surface 98 of the associated seat ring (Figs. 1 and 2). An arcuate cutout 142 extends through the side wall of the dead space ring. When the cutouts in the pair of dead space rings are placed in opposed relation to each other, they accommodate the actuating stem of the valve as best shown in Fig. 1. The cutouts are designed to closely receive the flange 44.

With respect to this preferred embodiment of the dead space rings, and upon assembly of the ball valve, the dead space rings 122 are initially fitted about the ball valve and the seal assemblies B are then placed into the valve chamber 12. The end fittings 14,16 are thereafter placed in abutting relationship with the valve body and retained in a valve assembled condition by the fasteners 26. Once assembled, the cavity 120, which was normally left open in the prior art valves, is now filled by the pair of dead space rings. The low frictional material does not increase substantially the torque required of an operator in rotating the ball member between valve open and closed positions.

Additionally, the dead space rings are formed of a rigid material so as to limit cold flow of the rings into the passageway 38 of the ball member. When the valve is closed, the dead rings must continually span the fluid passageway of the ball member. The dead space rings are unsupported in spanning the opening and are, therefore, subject to deflection and deformation. To minimize the likelihood of deformation, the dead space rings are formed of a rigid material, such as the impregnated polytetrafluoroethylene previously identified. This provides extended valve life while preventing interference with the mechanism

and advantages of the seal assemblies disposed in opposed relation to each other on opposite sides of the ball member. The overall assembly exhibits a low pressure sealing action that compensates for wear of the seal member and prevents contaminant entry into the valve chamber void.

Figs. 2A and 5A illustrate an alternative embodiment of the previously described dead space ring. Here too, only one seal assembly will be described in detail, it being understood that such description applies equally to the other seal assembly unless otherwise specifically noted. Additionally, for ease of illustration, like elements are identified by like numerals with a primed (') suffix and new elements identified by new numerals.

In Fig. 2A, a shoulder 80' includes first and second surfaces 82', 84', the second surface 84' adapted for abutting engagement with support ring 86'. This support ring is of simpler construction than was described with reference to Figs. 3 to 5 and includes an inner opening 90' and end faces 92', 94'. The seat ring 100' and disc spring 114' are of identical construction, whereby the seat ring is continuously urged into engaging, sealing relation with the ball member 36'.

The alternative dead space ring 122' of Fig. 5A is also of simpler construction than that of Figs. 3 to 5. A smooth outer surface 130' extends from an inner edge 132' to a rear surface 134'. The rear surface 134' abuts the support ring 86' substantially along the end face 92'. In addition, an arcuate cutout 142' is provided to closely receive flange 44' of the actuating stem in the same manner previously described. The use and function of this alternative dead space ring also is similar to that previously described.

The invention has been described with reference to preferred and alternative embodiments. Modifications and alterations are included within the scope of the claims.

CLAIMS

1. A rotary valve comprising:

a valve body having a valve chamber formed therein;

a valve member disposed in said valve chamber and adapted for rotary movement betweein open and closed positions;

an actuating stem co-operating with said valve member for transmitting an applied force for rotating said valve member;

a seal assembly including:

a radially inwardly extending bearing surface disposed on one side of said valve member;

a seat ring having a first surface adapted for abutting engagement with said bearing surface, a second rounded surface adapted for sealing relationship with said valve member, said rounded surface having a radius of curvature in an unstressed, unassembled condition greater than the radius of curvature of said valve member, said seat ring having an opening therethrough;

a disc spring interposed between said seat ring and said valve chamber and adapted for urging said seat ring into engagement with said valve member, said disc spring having a generally frusto-conical configuration in an unstressed condition; and

a dead space ring having a first rounded surface closely engaging said valve member, and a second surface in close engaging relation with said valve body, whereby said dead space ring substantially fills said valve chamber.

2. A rotary valve as claimed in claim 1, wherein said bearing surface includes a support ring.

3. A rotary ball valve comprising:

a body having a central passageway;

a ball member having a fluid flow opening therethrough, said ball member being positioned in said passageway and mounted for selective rotation between valve-open and closed positions to control fluid flow through said valve, said ball member having a radius of curvature on an outer wall surface;

a radially inwardly extending shoulder in said passageway disposed circumferentially thereof on one side of and generally facing said ball member;

a radially inwardly extending bearing surface in said passageway disposed circumferentially thereof on one side of said ball member, said bearing surface generally facing said shoulder;

a composite seat member assembly positioned axially in said passageway on one side of said ball member between said shoulder and said bearing surface for fluid-sealing engagement with said ball member, said seat member assembly including:

a seat ring adapted for elastic flexure generally towards and away from the associated bearing surface and having a central opening, a first surface generally facing said shoulder, a second surface abutting said bearing surface, and a third surface facing said ball member for sealing engagement with said outer wall surface of said ball member, said third surface of said seat ring being contoured and having a radius of curvature in an unstressed, unassembled condition greater than the radius of said ball member and

a disc spring having a central opening and a generally frusto-conical configuration in an unstressed condition and interposed between said seat ring and said shoulder; and

a dead space ring having a first curved surface closely engaging said ball member and a second surface generally facing said shoulder, whereby said dead space ring substantially fills said central passageway;

said ball member and said composite seat member assembly being sized so that, when assembled, said seat ring is flexed away from said bearing surface and stressed to have a

radius of curvature at said third surface of said seat ring generally equivalent to the radius of curvature of said ball member and is disposed in sealing engagement with said ball member over the extent of said third surface of said seat ring, said disc spring being stressed towards a flattened condition for continuously urging the third surface of said seat ring towards engagement with said ball member.

4. A rotary valve as claimed in claim 3, wherein said seat member assembly includes a support ring interposed between said bearing surface and said seat ring.

5. A rotary ball valve of the type including:

a valve body having a generally cylindrical fluid flow passageway;

a ball member having an opening therethrough, filling a major portion of said passageway and received therein for rotary movement between open and closed positions, said ball member being shiftable axially in response to fluid pressure conditions;

a pair of support rings disposed on opposite sides of said ball member and disposed at an inner axial position in spaced relation with said ball member;

a pair of seat rings disposed on opposite sides of said ball member and engaging respective ones of said support rings limiting axially inward movement of said seat rings, said seat rings having rounded surfaces adapted for sealing relationship with said ball member;

a pair of disc springs disposed on opposite sides of said ball member, said disc springs being positioned at an axially outermost position in said valve chamber and interposed between respective seat rings and walls of said passageway, said disc springs continuously urging said seat rings towards said ball member;

said support ring, seat ring, and disc spring pairs forming primary upstream and downstream seal assemblies; and

first and second dead space rings disposed on opposite sides of said ball member for filling a minor portion of said passageway, said dead space rings being interposed between said ball member along a rounded surface and a support ring along a second surface.

6. A rotary valve as claimed in claim 3, 4 or 5, wherein said dead space rings are formed of a rigid material for preventing cold flow into said opening of said ball member.

7. A rotary valve as claimed in any of claims 1 to 6, wherein said dead space rings are formed of a low friction material.

8. A rotary valve as claimed in any of claims 1 to 6, wherein said dead space rings are formed of polytetrafluoroethylene.

9. A rotary valve as claimed in claim 8, wherein said dead space rings are impregnated with a reinforcing fibre.

10. A rotary valve constructed and adapted to operate substantially as herein described with reference to and as illustrated in the accompanying drawings.

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